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OBSERVATIONS

O N

DOCTOR ARBUTHNOT'S

DISSERTATIONS

O N

COINS, WEIGHTS, and MEASURES.

By BENJAMIN LANGWITH, D.D.

Late Rector of *Petworth* in *Sussex*.



L O N D O N :

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E. O. W. D.

[The following is a list of the names of the persons who have been named in the report of the Committee on the subject of the proposed amendment to the Constitution of the United States, as passed by the House of Representatives, on the 1st of March, 1865.]

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To Her G R A C E the
Duchefs of S O M E R S E T.

M A D A M,

I OFFER these Papers to You, because I have been long desirous of making a public Acknowledgement of the great Obligations the deceased Author and present Editor have owed to his Grace of SOMERSET, and Your Self. Was I as able to describe the Variety of Accomplishments You are Mistress of as I am ready to own the Favours I have received, You are the only Person in the World who would read them with Uneasiness; but my Incapacity to do Justice to Your Virtues, prevents my offending one which gives a Lustre to
all

DEDICATION.

all the rest. However, Your Liberality and Benevolence which I have gratefully felt, tho' I cannot suitably express, shall live imprinted on the Mind of, MADAM,

YOUR GRACE'S

Most Obliged,

and most Obedient

Humble Servant,

Sarah Langwith.

OBSERVATIONS

O N

DOCTOR *ARBUTHNOT*'S

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O N

COINS, WEIGHTS, and MEASURES.

I AM very much obliged to Dr. *Arbuthnot* for giving me more Light into many curious Subjects, than I could have had without much Expence of Time and Labour. But this has not hindered me from making the following Strictures upon some Parts of his Work, in Hopes that one time or other they may contribute to its being brought to more Exactness and Perfection.

CHAP. I.

Of the ROMAN Pound.

I AM sorry to find, upon reading his Chapter of the *Denarius*, p. 15, that the *Doctor* has gone upon wrong Principles, and that his Tables of Weights and Coins are not

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only

Observations on Dr. Arbuthnot's

only loaded with useless Fractions, but are not so near the Truth as might be wish'd. The wrong Principles, those I mean which he had from Mr. *Greaves*, are as follow:

1. That the *Roman Ounce* is the same with the *English Avoirdupois*.

2. That the *English Penny* weighs eight Grains.

Mr. *Greaves* has been follow'd in the first of these Principles, not only by Dr. *Arbuthnot*, but by Bishop *Hooper* and Mr. *Smith*; tho' I believe it will be easy enough to prove it wrong. In order to this, let us first find the Value of the *Avoirdupois Ounce*; then that of the *Roman* in Grains Troy.

By an Experiment in *Ward's Young Mathematician's Guide*, p. 32, it appears, that a *Pound Avoirdupois* weighs 14 oz. 11 pw. 15 $\frac{1}{2}$ gr. or 6999.5 Grains Troy.

He calls this Experiment a nice one, and I have Reason to believe it so, for I made the same myself, and find but a trifle of a Difference.

I fancy Mr. *Greaves* made the same Experiment, by weighing a Standard *Avoirdupois Pound* with Troy Weights; and was the first who determin'd the Proportion of the *Avoirdupois Pound* to the *Troy Pound* to be as 175 to 144, and consequently the *Avoirdupois Ounce* to be 437 $\frac{1}{2}$ Grains Troy, which differs very little from the *Avoirdupois Ounce* fetch'd out by Mr. *Ward's Pound* of 6999.5; for if 6999.5 be divided by 16, the Number of Ounces in an *Avoirdupois Pound*, it will give

The *Avoirdupois Ounce* 437.468, &c. Grains Troy, which falls short of the foremention'd *Avoirdupois Ounce* 437.5 by only 0.032 of a Grain. The foremention'd Proportion also is used by Bishop *Hooper*, but whence he had it we are not told. *Vide Arbuthnot*, p. 283.

As for Dr. *Arbuthnot*, in order to find the *Avoirdupois Ounce*, which he will have to be the *Roman*, tho' without any

any manner of Proof, he first makes use of the Proportion of the *Avoirdupois* Pound to the Troy Pound, as 175 to 144, which would bring out the *Avoirdupois* Ounce $437\frac{1}{2}$ Grains Troy, and being multiply'd by 12 gives what he calls the *Roman* Pound.

Afterwards he changes his Proportion of the Pounds for a much worse, from Dr. *Wybert*, viz. instead of 175 to 144, he makes use of 17 to 14, throwing off the last Figures in the former Numbers.

By this Preparation, the *Avoirdupois* Ounce will come out 437.142 Grains *Troy*, and what he calls the *Roman* Pound 5245.704 Grains *Troy*, which he makes use of in his Tables. This new *Avoirdupois* Ounce of his, differs more from the true *Avoirdupois* Ounce, than the Former, for that differed from it only by 0.032 of a Grain, this by 0.326 of a Grain.

The *Avoirdupois* Ounce being thus settled at 437.468 Grains *Troy*, let us next enquire after

The ROMAN Ounce.

I know no better Way of coming to this, than by the Weight of the *Denarius*; for since it is agreed that 7 *Denarii* make an Ounce, if we have the Weight of the *Denarius*, we have that of the Ounce too. The Question is, how we shall know the Weight of the *Denarius*? One would think the Answer was easy. —By weighing it.

This Mr. *Greaves* has done; and having in *Italy*, and elsewhere, perused many hundred *Denarii Consulares*, he found by frequent and exact Trials, the best of them to amount to 62 Grains *Troy**. Surely this is a more na-

B 2 tural

* The *Denarius* is certainly set high enough at 62 Grains, and it is not common to meet with one that weighs so much. I have but one in my Collection that comes near it; and in that great Number, whose Weights Mr. *Thoresby* sent to Mr. *Smith*, there is but one of 62 Grains.

tural way of coming at the Weight of the *Consular Denarius* than the round-about Methods by *Vespasian's Congius*, *Inch Measure*, &c. The Imperfections of some, or all of which, I shall shew hereafter.

I am sensible that Bishop *Hooper* sets the *Denarius* at 64 Grains; but I do not know how he could make it out, nor indeed how to reconcile this with his Notions, that the *Avoirdupois* Ounce consists of 437.5 Grains *Troy*, which it must do according to the Proportion which he makes use of, and the Supposal that the *Roman* and *Avoirdupois* Ounces are the same; for if the *Roman Denarius* be 64 Grains, the Ounce must be $64 \times 7 = 448$ Grains *Troy*, which exceeds his *Avoirdupois* or *Roman* Ounce, by no less than 10.5 Grains.

We are told of *Denarii* of very large Sizes by Mr. *Thoresby*; but these are nothing to the Purpose, since he himself neither takes them to be *Consular*, nor indeed so much as struck at *Rome*. Vide *Duc. Leod.*

Dr. *Bernard* is also quoted by Mr. *Smith*, p. 154, as having seen some *Denarii* of *Drusus*, which amounted to 62 gr. $\frac{4}{7}$. I cannot help taking this to be accidental; however, it may well enough be accounted for. I suppose they were the *Denarii* of that *Drusus*, who, as we are told by *Pliny*, mixed no less than an eighth Part of Brass with the Silver: So that it is no wonder if he was not so nice in his Weight as to trouble himself about $\frac{4}{7}$ of a Grain.

I shall therefore stick to 62 Grains *Troy* for the weight of the *Denarius*, at which Rate the *Roman* Ounce will be 434 Grains *Troy*, the *Roman* Pound 5208 Grains *Troy*, or 10 $\overline{3}$. 17 *pw. Troy*.

The Difference between the *Roman* and *Avoirdupois* Ounce will now plainly appear: For since the *Roman* Ounce contains only 434 Grains *Troy*, but the *Avoirdupois* 437.468, &c. the *Avoirdupois* Ounce will exceed the *Roman* by 3.468, &c. which does not seem to be much in the Ounce, but will
make

make a great Difference when it comes to be multiplied by 12, or a greater Number.

Dr. *Arbutnot's* Tables of Weights then are imperfect by his making the *Roman Ounce*, and consequently all the corresponding Weights, too heavy; for according to his Tables, the Ounce ought to be 437.142 Grains *Troy*; so that his *Roman Ounce* exceeds the true *Roman Ounce* of 434 Grains by 3.142 Grains *Troy*.

We must not yet dismiss this Point; for Mr. *Greaves* had so strong an Opinion, that the *Roman Ounce*, and *Avoirdupois Ounce*, was the same; that not being content with the *Denarius* of 62 Grains, with its corresponding Ounce 434 Grains, he casts about for a new *Denarius*, whose corresponding Ounce might be nearer the *Avoirdupois Ounce*. What this *Denarius* and Ounce were, we shall quickly see.

In the mean time, I cannot help wondering why Mr. *Greaves, &c.* should imagine we had our *Avoirdupois Ounce* from the *Romans*; for,

1. By the Name of it, I should imagine much rather, that we had it from the *French*.

2. If we had the *Avoirdupois Ounce* from the *Romans*, it is strange we had not the Pound too, which then would have consisted of 12 Ounces instead of 16.

3. It is plain it does not answer the Weight of the Consular *Denarii*. These are to me probable Arguments at least, that the *Romans* did not leave their Ounce in *Britain*, as Dr. *Arbutnot* asserts.

I shall now proceed to Mr. *Greaves's* second *Denarius*, which is $62 \frac{4}{7}$ Grains *Troy*. This *Denarius* exceeds the Former by $\frac{4}{7}$ of a Grain, which he is obliged to maintain, were lost in the Coins by the Coinage, &c. This *Denarius*

is fetched from the *Congius of Vespasian*, by *Villalpandus*, in the following manner :

The *Congius* called *Vespasian's*, being marked on the Outside P. X. is supposed to have contained ten *Roman Pounds*. This Vessel *Villalpandus* filled with Water, and found it to contain ten *Roman Pounds*, such as are used at present in *Rome*. He thence concludes, that the present *Roman Pound*, and the ancient *Roman Pound*, are the same. His Conclusion would be just, was it certain that the *Congius* was exact, and that the Experiments were made with that exquisite Nicety, that Experiments in weighing of Water, especially in such large cumbersome Vessels, require. Mr. *Greaves*, upon the Credit of *Villalpandus* [for I do not find that he weighed the Contents of the *Congius* himself] took the ancient *Roman* and present *Roman Pound* to be the same. After this I suppose he weighed the present *Roman Pound* with *Troy Weights*, and found it to contain 5256 Grains *Troy*, and consequently, that the Contents of the *Congius* being ten Pound, were 52560 Grains *Troy*. These 52560 Grains being divided by 840, the Number of the *Denarii* in 10 *Roman Pounds*, will give $62\frac{480}{840}$, or $62\frac{4}{7}$ for the *Roman Denarius*, whose correspondent Ounce will be 438 Grains *Troy* *.

This Ounce from the *Congius* differs but little from the *Avoirdupois Ounce* 437.468, viz. 0.53, $\frac{1}{20}$ of a Grain; so that they might well enough pass for the same, if so near an Agreement had been proved any other way. But I am afraid the Arguments taken from this *Congius* are far from being conclusive, and that for the following Reasons, which surely so curious and exact a Person as the excellent Mr. *Greaves* could not but have thought of, had he not been prejudiced in favour of an Opinion which is inconsistent with them.

* Vide *Ward's Dissertation de Asse*, in *Aynsworth's Monumenta Kempiana*.

them. The Reasons why I think the Arguments from the *Congius* inconclusive are,

I. In general, because I think no Water Measure can be exact, and that,

1. Because different Waters have different Weights, Rain-Water differs from Spring-Water, and the Water of one Spring from that of another.

2. Because the Weather makes an Alteration in the Weight of Water, since, according to Mr. *Homberg*, the same Quantity of Water [I suppose he means of the same Kind of Water] which in Winter weighed 474 Grains, weighed in Summer only 470 Grains, and consequently lost something above $\frac{1}{113}$ Part of its Weight. *Vide* Arbuthnot, p. 82.

3. Because there is much Difficulty in filling Vessels with Water to great Exactness; for if the Vessel be well dried and cleansed with Bran or Flower, the Water will stand in a Crown above the Brims, and be heavier than the Dimensions of the Vessel require; but if this Water be taken off with a Strike, it will not touch the Brims of the Vessel, and so be lighter than the Dimensions of it require. Thus much as to the Uncertainty of Water-Measure in general. I come to consider,

II. Why Arguments from this *Congius*, in particular, are inconclusive; and that,

1. Because it is neither rectangular nor cylindrical, but bulges out in the Belly, and therefore could never be designed for an exact Measure, since without a great deal of Trouble, Part of the Liquor in pouring it out would be left behind. Perhaps they made it larger than ordinary, partly to allow for this Inconvenience, and partly to allow for the
Liquor

Observations on Dr. Arbuthnot's

Liquor that might be dashed about in pouring it in and out ; for that it was larger than ordinary, is certain ;

3. Because the *Denarius* and Ounce taken from it are larger than ordinary.

4. Because the Foot taken from it is larger than ordinary ; for the Foot taken from this *Congius* would be 11.84 Inches, differing from the *Cossutian* Foot by an Excess of near $\frac{1}{5}$ th of an Inch. *Vide Arbuthnot, p. 81.*

5. What is worst of all, it is suspected to be spurious. *Vide Gruter Inscript. vol. 1. p. 233.* Though no Reasons are offered there why it is suspected, yet to say nothing of the absurd improper Figure of it, I think a very good Argument to prove it a Counterfeit may be taken from the Inscription upon it, which runs thus :

IMP. CAESARE
VESPAS. VI. COS
T. CAES. AVG. F. IIII
MENSURAE
EXACTAE IN
CAPITOLIO
P. X

To say nothing of the other Parts of the Inscription which are suspicious enough, the Omission of COS in the third Line before IIII. is sufficient for me to judge it spurious. I think at least, it is not of Authority enough to support the Notion grounded upon it, that the *Avoirdupois* and *Roman* Ounces are the same. I have also shewed the Mischief that Dr. *Arbuthnot* has done his Tables by falling into this Error.

There is still another Estimate of the *Denarius* at p. 15, from a Model of the *Congius* of *Vespasian*, which is hardly worth mentioning. This makes the *Denarius* $62\frac{361}{435}$, or 62.839 Grains *Troy*. At this Rate, the Ounce will be 439.873, and the Pound 5278.476 Grains *Troy*.

By setting, as I have done, the *Roman Ounce* at 434 Grains *Troy*, and the *Roman Pound* at 5208 Grains *Troy*, neither the Ounce nor the Pound are incumbered with Fractions, which cannot be said either of Dr. *Arbuthnot's* Ounce or Pound.

It may perhaps create a Prejudice to my Estimate of the *Roman Ounce* and *Denarius*, when it is considered that such great Men as Mr. *Greaves*, Bishop *Hooper*, and Dr. *Arbuthnot* have set them higher than I have done. In order to balance these great Authorities, I shall take in the Assistance of *Lucas Pætus*, and *Savotus*, two very learned Men, and curious Observers, whose Ounce and *Denarius* are much lower than mine.

1. As to *Pætus*, he tried a very nice Experiment with an Amphora, made by the *Roman Foot*, and a proportionable *Sextarius*, of which an Account may be met with in *Ward de Asse*, p. 48. The Result of his Experiment was, that the *Roman Pound* consisted of 5000.5 Grains *Troy*. This Pound, which is lighter than Mr. *Greaves's* of 5256 by 255.5 Grains, will give the Ounce 416.708 Grains, and the *Denarius* 59.529 Grains *Troy*.

2. *Savotus* makes this still too much, and by weighing many Gold and Silver Coins, concludes, that 68 of our Grains *Troy* are to be taken from *Pætus's* Pound, in order to bring it right. Thus his *Roman Pound* will be 4932.5, his Ounce precisely 411.041 Grains *Troy*, his *Denarius* 58.72 Grains *Troy*.

Pætus's Pound of 5000.5 falls short of mine 5208 by 207.5 Grains *Troy*.

Savotus's of 4932.5 Grains *Troy* falls short of mine by 275.5 : So that according to them my Pound is much too large; and instead of falling short of Mr. *Greaves's*, by only 48 Grains *Troy*, it ought to do it by 4 or 5 times as much.

The same may be said in Proportion of the Ounce and *Denarius*.

I shall not however quit my Estimate of the Ounce, &c. for either of theirs.

1. Not for *Pætus*'s : I do not doubt of the exceeding great Care and Exactness of *Pætus* ; but, for Reasons given before, I cannot think Water-weight any thing near so exact as solid Weight. But there is another Objection against his Estimate ; for it is very doubtful whether the Amphora from the Foot be exact. It certainly comes near the Amphora found by Weight, but cannot be proved to be the same. *Vide* Bishop *Hooper* in *Arbuthnot*, p. 81. It seems to be something less, and so brings down the Weight of the Ounce, &c.

2. As to *Savotus*, he is an Adversary worse to manage, for his exquisite Nicety about Coins is well known ; and he fetched out his Pound, &c. by weighing Gold and Silver Coins ; so that it is strange that his *Denarius* should differ so much from Mr. *Greaves*'s of 62 Grains *Troy*. All that I can say to it is, that either the Coins he met with were not so perfect as Mr. *Greaves*'s, or else, that having weighed several, he chose to set them at some middle Rate, rather than at the highest or the lowest.

I shall just take notice, that the *As Libralis*, even when fair, does not weigh above 9 Ounces *Troy*, which is a probable Argument, at least, that my Pound is not set too low at 10 $\frac{3}{4}$, 17 *pw*.

Several of these Particulars may be seen in Mr. *Ward*'s *Dissertation de Asse*, in *Monument. Kempian*. from p. 46, to p. 62. And yet after all, this Author chuses to stick to Mr. *Greaves*'s Computation ; and that for a very odd Reason, *viz.* that it is used by our Authors, particularly Dr. *Arbuthnot* ; as if it was not better to correct our Authors, and, particularly,

Dr.

Dr. *Arbuthnot* as well as the rest, than follow them in their Errors.

The Computation that he talks of, is that which sets the *Denarius* as $62\frac{4}{7}$ Grains *Troy*, and the Penny at 8 Grains; which latter is undoubtedly false, as I shall shew, after having given the Pounds, Ounces, and *Denarii* mention'd in these Papers at one View.

	<i>Pound.</i>	<i>Ounce.</i>	<i>Denarius.</i>
<i>Greaves's</i> Computation from } <i>Villalpandus</i> gives, - - - }	5256	438	$62\frac{4}{7}$
Dr. <i>Arbuthnot's</i> , - - - -	5245.752	437.142	62.448
Mine from the <i>Denarius</i> - -	5208	434	62
<i>Pætus's</i> , - - - - - - -	5000.5	416.708	59.529
<i>Savotus's</i> , - - - - - - -	4932.5	411.041	58.72
Another in <i>Arbuthnot</i> , - - -	5250	437.5	62.5

I wonder the *Doctor* did not stick to this Pound, which is a whole Number, especially, since the Ounce of it is near the *Avoirdupois* Ounce, which he takes to be the *Roman*.

The Difference between his Pound of 5245.752, &c. mine 5208 is 37.752, &c. Grains *Troy*, which is little more than $\frac{1}{152}$ of a Pound *Troy*; consequently in a little more than 152 Pounds Weight, his would exceed mine by a Pound *Troy*. I think I have proved mine to be the true *Roman* Pound; and if I have, it is plain that his is too heavy. It is plain also from what went before, that his Over-weight was chiefly owing to his following Mr. *Greaves* in his Notion, that the *Roman* Ounce and *Avoirdupois* Ounce are the same.

I shall now give an Account of the *Roman* Weights according to my Computation, and then shall proceed to the Consideration of his second general Mistake, which has spoiled his Tables of Money, as the first did those of Weight.

		Gr. Troy.	℥	Pwt.	gr.
My Roman Pound, is - -		5208	10	17	00
Ounce, - - - $\frac{1}{12}$		434	00	18	02
Duella, - - - $\frac{1}{36}$		144 $\frac{2}{3}$	00	06	00 $\frac{2}{3}$
Sicilicus, - - - $\frac{1}{48}$		108 $\frac{1}{2}$	00	04	12 $\frac{1}{2}$
Sextula, - - - $\frac{1}{72}$		72 $\frac{1}{3}$	00	03	00 $\frac{1}{3}$
Drachma, - - - $\frac{1}{96}$		54 $\frac{1}{4}$	00	02	06 $\frac{1}{4}$
Scriptulum - - - $\frac{1}{288}$		18 $\frac{1}{2}$	00	00	18 $\frac{1}{2}$
Obolus, - - - $\frac{1}{576}$		9 $\frac{1}{24}$	00	00	9 $\frac{1}{24}$
Siliqua, - - - $\frac{1}{1728}$		3 $\frac{1}{72}$	00	00	3 $\frac{1}{72}$
Lens, - - - $\frac{1}{6912}$		0 $\frac{217}{288}$	00	00	0 $\frac{217}{288}$

I am aware that it would have been better to have thrown the common Fractions into the Decimals in this Table; but I have drawn it up in this manner to make it more easy to be compared with Dr. *Arbuthnot's*.

This over-rating the *Roman* Weights, will occasion Disorder in the Estimate of the Measures both wet and dry.

C H A P. II.

Of the Value of ROMAN Money in ENGLISH Coin.

I SAID in the Beginning of the last Chapter that the *Doctor's* Tables of Coins are not so exact as might be wish'd, which was partly occasion'd by his following Mr. *Greaves* in two Inaccuracies. The first has been treated of.

The second is, That he has set the *English* Penny at 8 Grains *Troy*, and in consequence the *Denarius* at $7d. \frac{3}{4}$ *English*; which is too low.

If a Pound Sterling of Silver was coin'd into 60 Shillings, or what is the same thing, the Ounce of Silver, into 60 Pence, then indeed the Penny would be 8 Grains *Troy*.

For as $60d. : 480gr. :: 1d. : 8gr.$ thus also
as $480gr. : 60d. :: 62gr. : 7d. \frac{3}{4}$

Both Dr. *Arbuthnot* and Mr. *Greaves*, knew well enough that an Ounce was coin'd into 62 Pence; but in order to save a little Trouble in Calculation, set it at 60 Pence. They would have saved a great deal more Trouble by setting it right; since by that the *Denarius* would have come out at about 8d. the *Quinarius* at 4d. and the *Sestertius*, by which all great Sums are estimated, at the round Number 2d. which may be thus made out.

If 480 the Number of Grains *Troy* in an Ounce give 62 Pence, then will 62 Grains, which are contain'd in a *Denarius*, give $8.008, \&c.$

Observations on Dr. Arbuthnot's

$$\begin{array}{ccccccc} & \text{gr.} & & \text{d.} & & \text{gr.} & \text{d.} \\ \text{As} & 480 & : & 62 & : & 62 & : 8.008, \text{ or,} \\ \text{As} & 480 & : & 62 & : & 62 & : 8 \frac{1}{120} \end{array}$$

The Fraction 0.008 or $\frac{1}{120}$ may well enough be omitted, tho' in 120 *Denarii* it would amount to an *English* Penny. It is certain from *Pliny*, Edit. *Hard. Tom. I. p. 627, Fol.* that the Mint-Masters did not always make the *Denarii* of the just Weight, which perhaps may be one Reason why amongst the many fair *Consular Denarii*, as they are called, so few come up to the Weight of 62 Grains *Troy*.

I shall conclude therefore, that the *Denarius* is 8 Pence, that it is set a Farthing too low at $7d. \frac{3}{4}$, and the *Sestertius* a Quarter of a Farthing too low at $1d. 3f. \frac{3}{4}$.

A Quarter of a Farthing seems to be an inconsiderable Thing; but when it comes to be multiplied, as the Sums which we often meet with in the *Roman* History require, it will then appear to be of more Consequence. I shall instance only in *Centies H. S.* which was no uncommon Estate among the *Romans* after the Conquest of *Carthage*, *Greece*, *Asia*, &c. *Centies H. S.* supposing the *Sestertius* to be $1d. 3f. \frac{3}{4}$, would amount to $80729l. 3s. 4d.$ but setting the *Sestertius* $\frac{1}{4}$ of a Farthing higher, or, in other Words, at $2d.$ the Sum will be $83333l. 6s. 8d.$ the Difference $2604l. 3s. 4d.$

The former Conclusion will be confirm'd, by considering what the real Weight and Value of the 60 Pence or Crown, and Penny will be, when the Ounce is coin'd into 62 Pence: The Value of the Crown in this Case will be no more than $58d.$ and about $\frac{1}{4}$ of a Farthing, the Weight of it no more than $19pw. 8gr. \frac{1}{2}$, with some exceeding small Fraction. The Penny at the same Rate will be no more in Value than $3f. \frac{54}{62}$, supposing the Ounce to be 60 Pence, nor in Weight than $7gr. \frac{46}{62}$, or $7gr. 74, \&c.$ so that it was over-rated in Weight by

by Mr. *Greaves* and Dr. *Arbuthnot*, something more than a Quarter of a Grain, viz. $\overset{\text{gr.}}{0} \ 26$; which in 8 *d.* would amount to $\overset{\text{gr.}}{0.26} \times 8 = \overset{\text{gr.}}{2.08}$, something above a Farthing.

The *Denarius* being thus settled at 8 *d.* of our Money, the *Roman Libra* of Silver 5208 Grains *Troy* will be $8 \times 7 \times 12 = 672 = 56 = 2 \ 16 \ 0$.

					<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>f.</i>
<i>Denarius</i> ,	-	-	-	-	0	0	8	0
<i>Quinarius</i> ,	-	-	=	$\frac{1}{2}$	0	0	4	0
<i>Sestertius</i> ,	-	-	=	$\frac{1}{4}$	0	0	2	0
<i>As</i> ,	-	-	=	$\frac{1}{10}$	0	0	0	$3\frac{1}{5}$
<i>Sembella</i> ,	-	-	=	$\frac{1}{20}$	0	0	0	$1\frac{3}{5}$
<i>Teruntius</i> ,	-	-	=	$\frac{1}{40}$	0	0	0	$0\frac{4}{5}$

Mr. *Smith* has calculated a large Table of *Roman Sums*, at the Rate of 2 *d.* the *Sestertius*. I wish this had been done by a more exact Author ; for his Numbers are so faulty in many Parts of his Book, that I am afraid the Tables are hardly to be depended upon.

CHAP. III.

*Further Considerations upon the VALUE of the
DENARIUS.*

I THINK the *Denarius* is rightly adjusted to our Money in these Papers; but it is upon a Supposition that the *Denarius* is of its just Weight 62 Grains *Troy*, and of the same Fineness of the *English* Coin; for a Difference in either of these Particulars must occasion an Alteration in the Estimate.

As to the former of these; 'tis certain that many of the *Roman Denarii* fall short of this Weight by several Grains, which yet might have had it at their first Coinage, such a Loss being easily accounted for by wearing, and other Accidents, in so many Hundred Years. It is no more, in very many of them, than what has happened to a less Coin of our own in a very few Years; for I have just now weigh'd an *English* Sixpence of King *William's*, that has lost seven Grains of its due Weight, and I don't doubt but that there are many which have lost eight.

I cannot, however, be certain that all the *Denarii* had their just Weight even in the Time of the Consuls, from a remarkable Place in *Pliny*, which I shall transcribe at length, since I shall have further Occasion to make use of it. *Vide Plin. Edit. Hard. Tom. ii. p. 627*, and runs thus: *Miscuit denario Triumvir Antonius ferrum. Miscentur æra falsæ monetæ. Alii e pondere subtrahunt, cum sit justum 84 e libris signari. Igitur ars facta denarios probare, tam jucunda lege plebi, ut Mario Gratidiano viciatim totas statuas dicaverit.*

As to the second of these Particulars, the Fineness of the Silver, the Antiquarians are not well agreed about it. *Savo-*

tus

tus, whose Judgment in those Particulars is much to be relied on, says, *La plupart des metalls et monneys antiques Romains ont été battues sur le fin.* Vide *Rink.* p. 52.

I am obliged to quote *Rink* for this, as not having *Savotus* by me; and indeed I suspect it relates chiefly to the Gold Coins, which were generally of the purest Gold. Vide *Joubert*, p. 17. As to the Silver, the same Author maintains that the best of the *Consular Denarii* fall short of the *French* Standard, which as well as the *Spanish* is nearly the same with ours, by $\frac{1}{6}$ Part. At this Rate, since our Standard has about $\frac{1}{13}$ part of Alloy in it, the Alloy of the *Roman Denarius* would have $\frac{1}{6} + \frac{1}{13}$ Parts of Alloy in it, which two Fractions added together make $\frac{19}{78}$ and above $\frac{1}{4}$ of Alloy.

What Experiments were made by Mr. *Joubert* to come at this Conclusion I cannot tell; but I am afraid they were not made upon a sufficient Number of Coins, or not made with due Exactness; for it will quickly appear by the Trials that I made, that the best of the *Consular* Coins are so far from sinking so strangely below our Standard, that they equal, or even exceed it. This I think conclusive against Mr. *Joubert*.

As a probable Argument against him, I might take notice that the greatest Debasement that we read of the Silver in the *Roman Denarius*, was made by the Tribune *Livius Drusus*, who mixed an eighth Part of Brass with Silver, *A. U. C.* 663, during the Consulate of *Lucius Marcius Philippus*, and *Sextus Julius*. Vide *Plin. Edit. Hard. fol. Tom. ii. p. 612*. We are told that the Brass was of the purest; but we are not told what the Silver was; but surely it could not be so base, however, as to sink to Mr. *Joubert's* Proportion of Alloy. I shall try this afterwards.

There are sufficient Reasons to think that the *Romans* were but poor Masters at refining of Silver, which might possibly occasion a Difference in the Goodness of their Coins, by

trusting to Chance for want of a certain Standard. They were able to manage Gold well enough, to which they could not give too much Fire. Silver Ore requires a great deal more Art to bring it to Perfection without great Loss, than they ever seem to have been Masters of. What has been often observed in *England* does no great Credit to the *Roman* Skill in the Management of their Metals; for the Cinders of some old Iron-works, supposed to be theirs, still contain in them such a considerable Quantity of good Iron that they are melted over again, in order to extract it.

The finest Brass seems to have been less weighty than our Copper, especially if the specific Gravity of it be set at 9.000, which I own I think too much; because the Estimate seems to have been made from Pieces of Coin. The violent Force which is used in Coinage, makes the Parts of the Metal lie closer, and thus increases the specific Gravity. The specific Gravity of a Silver Half-Crown of *William III's*, in *Harris's* Tables of specific Gravity, is set at 10.75, whereas, at the Rate of our Standard, it ought to be no more than 10.535. I should rather chuse therefore to set the specific Gravity of Copper at 8.843, and have just Reason to imagine from the specific Gravity of some of the following Coins, that the *Roman Æs purissimum* did not come up even to that.

In order to obtain some Insight into this Matter, I took five *Consular Denarii* and weighed them carefully; first in Air, then in Water, that I might not only have their Weights, but their specific Gravities.

1. This was a very fair Coin, ferrated, and well preserved: It has on one Side the Head of *Jupiter*, in whose Face is a wonderful Mixture of Sweetness and Majesty; at the back of the Head is S. C. and under it O, I suppose for *Senatus Consulto*. On the Reverse is a Victory driving a *Quadriga*. The Letters in the Exergue are so confused and imperfect, that

that it requires better Eyes than mine to make them out. By the Inscription S. C. O. the Coin was struck by the Authority of the Senate, which perhaps made the Mint-masters more careful, than when they wrought by the Authority of the Consuls, Prætors, Ædiles, &c. as they did sometimes. *Vide Rink, p. 123.*

The Weight of this Coin, in Air, is	- - - -	^{gr.} 61.625
in Water, - - -	- - -	55.875
Difference - - -	- - -	<hr/> 5.750

The Way to find the specific Gravity is this : As the Difference between the Weight in Air and Water is to the Weight in Air, so is 1.000 to the Number sought. Thus as 5.750 : 61.625 :: 1.000 : 10.717, &c. Which last Number 10.717, shews the specific Gravity. Since the specific Gravity of our Standard Silver, is generally set at 10.535, it seems at first Sight as if this Coin considerably exceeded our Standard. Yet if we consider the specific Gravity of King *William's* Half-crown, mentioned before, at 10.75, it will appear that this *Denarius* is exceeded by it but a Trifle. Nay, since this *Denarius* has a very bold Relief, it must have been compress'd and condens'd so much in the Coinage, that it is a Question whether the Metal of it before Stamping, was any thing heavier than our Standard.

This Coin is specifically heavier than any of those that follow ; consequently it is of finer Silver : For an Alloy of any base Metal will make Silver lighter, Lead only excepted : But we have *Savotus's* Word for it, that in his *Essays* on ancient Coins, he never met with a Grain of Lead in any of them before the Time of *Septimius Severus*, when a Mixture of Brass and Lead was made use of to allay the Silver. *Vide Joubert. p. 22.*

This Coin is so remarkable, that I cannot leave it without some further Observations.

1. That as it, after so many Ages, falls short of 62 Grains *Troy*, only by $\frac{1}{4}$ of a Grain ; I think no Doubt can be made but that it must have weighed full 62 Grains.

2. That as it is a *Nummus Serratus*, and yet comes so near its full Weight, it must either have been notch'd at the Mint before it was delivered out, or notch'd with a Chizzel so as to make little Loss ; or, lastly, that it weighed when it was coin'd, considerably more than it does now.

3. That tho' this, and some other Coins of the Consular Kind, may weigh about 62 Grains *Troy*, and be nearly about the Fineness of our Standard, and so be worth about 8 *d.* of our Money ; yet I own, that much the greatest Part of them fall short, either in Purity or Weight : The Reasons of which are partly to be collected from the above-cited Place in *Pliny*, as also from the Effects of Time, Wearing, Rust, and other Accidents. I take this first to have been a *Denarius* in Perfection, according to the Notion of the *Romans* ; and upon such *Denarii* I have founded my Computation.

I took notice that the specific Gravity of Metals may be increased by the Compression in Coinage. This may be confirmed by what happens in other Cases. The specific Gravity of cast Brass, for instance, is but 8.000, or at most 8.100 ; whereas the specific Gravity of hammer'd Brass is 8.349.

I shall call this first Coin *Jupiter*.

The second I examin'd was a fair one, and but little worn ; which had on one Side a Head, I think, surrounded with a Diadem ; behind it is a Lituus, below it the Inscription ANCUS. On the Reverse is a Man on Horseback with a Dog,

Dog, as I take it, below. To the left of this Figure, is the Inscription *Philippus*. Immediately below the Horse and seemingly contiguous to it, is an Aqueduct among the Arches, on which is A QVA MARC I A.

				gr.
The Weight of this <i>Denarius</i> ,	in Air	-	-	59.625
	in Water	-	-	53.375
				<hr/>
Difference				- - 6.250

The Proportion for finding the specific Gravity, is as 6.250 : 59.625 :: 1.000 : 9.54.

I made two other Trials, one of which brought out the specific Gravity 9.44, the other something less; so that I shall pitch upon 9.44, as most likely to be exact; tho' indeed there is very little Difference between any of the three. This specific Gravity is less than that of any of the following Coins, and much less than some of them; and indeed I have Reason to think it one of them which *Livius Drusus* allay'd with an eighth Part of fine Brass; which, as we are told by *Pliny*, he did. It must however be observed, if his Brass was as heavy as our Copper at 9.000, his Silver must have been very impure, which may thus be made out:

Suppose 8 Parts of Metal, 7 of which are of Silver and one of Copper, which last has for its specific Gravity 9.000. If we suppose the Silver at 9.5, the Compound of the two will have exactly 9.4375 for its specific Gravity; which will appear by multiplying 9.5 into 7, the Number of Parts of Silver, which gives 66.5, to this is to be added 9.000 for the single Part of Copper, in all 75.5, which being divided by 8, gives 9.4375. This specific Gravity 9.4375, is the same within a Trifle with that *Ancus* was set at, viz. 9.44.

Were

Were we to debase the Copper to 8.000, the specific Gravity of this Silver would be near 9.6. If the Copper was supposed still lighter, and set only at 7.000 the specific Gravity of the Silver would not be quite 9.8. Upon the Whole it is evident, that if the Brass was pure, the Silver was very base; and if we suppose the Brass to be so debased as to have only the specific Gravity 7.000, the Silver would be then also base, since it would fall short of the Standard of pure Silver 11.091 by $[11.091 - 9.8 =] 1.291$. It would also fall short of our Standard, even of uncoin'd Silver, 10.535 by 0.735, and of our coin'd Silver 10.535 by 0.95.

I shall conclude, upon the Whole, that this was one of *Drusus's Denarii*, and that in Compliment to one of that Year's Consuls, *Lucius Marcius Philippus*, whose Family might possibly pretend to be derived from *Ancus Marcius*, the King's Head of that Name was stamp'd upon one side of the Coin, and on the other *Aqua Marcia*, with the Name *Philippus*.

I think it worth taking notice of, that here is no more of the Consul's Name upon this Coin than barely PHILIPPVS, without the Title of COS: For tho' the *Romans* suffer'd the *Triumviri Monetarii* to set their Names, and little Titles, upon their Coins, yet they were shy of the great Magistrates, Consuls, Tribunes, &c. whose Names and Titles never appear'd upon any Coins struck in their own Times, till the Decay of the Commonwealth.

As I think it very plain, that this *Denarius* was one of those of *Livius Drusus*, so I think it probable that the other was one of those struck by the Authority of the Senate; who after they had abrogated all the Constitutions of *Drusus* by one Decree, seem to have taken the Coinage into their own Hands, and to have raised the Coin to as great a Degree of Perfection as ever it had before, if not greater. I shall call this Coin *Ancus*.

The third *Denarius* that I shall consider has a Head of *Roma* on one Side, having on a Helmet with Wings annexed. The Inscription is ROMA. On the Reverse is a Victory and a Quadriga. In the Exergue is the Inscription M. TVLL.

The Weight of this in Air	-	-	-	gr.	57.875
Water	-	-	-		52.125
Difference	-	-	-		5.750

The specific Gravity - - 10.0652, &c. - - For
as 5.75 : 57.875 :: 1.000 : 10.0652, &c.

Notwithstanding we are able to find the specific Gravity and Weight of this, and the two following Pieces, yet we are more at a Loss to tell their Value in *English* Money, or indeed their Proportion to one another in Goodness, than in the former Coin ; for in that we were told that the Alloy was $\frac{1}{8}$ of pure Brass, which was of some Assistance in judging what was the Value of the Silver ; but in these, supposing they were allay'd with Brass, as it is probable they were, yet since we neither know the specific Gravity of the Brass, nor of the Silver that is mix'd with it, we can be at no manner of Certainty. I shall therefore content myself with giving their specific Gravities and Weights, by the former of which we shall know, how much the Mixture falls short in Weight of pure or Standard Silver. I shall call this Coin *Rome the bigger*, or *Roma Alata*.

The fourth *Denarius* that I tried has no *Alæ* annexed to the Helmet, as far as I can see ; I shall therefore call this only simply *Roma*. Upon the back of the Head is X, for *Denarius*. There are either Bigæ or Quadrigæ on the Reverse,

verse, but the Coin is so much worn, that I cannot tell which; nor can I make out any Letters but the X.

		gr.
This Coin weighs in Air	- - -	52.25
Water	- -	47.25
		<hr/>
	Difference	- 5.00
Specific Gravity	10.45	

The fifth *Denarius* has upon one side, what *Hardouin* calls *Caput barbarum* [perhaps for *barbatum*] & *ignotum*: But, for my Part, I take it to be *Jupiter* under the Notion of *Pan*, who upon this Account hath a longer and sharper Beard than ordinary given him. *Vide Collier's Appendix*, under the Word *Pan*.

I suppose *Pansa* chose *Pan*, because it had some Affinity to his own Name. There are many Instances to shew how fond even the *Romans* were of Rebus's, little Allusions, &c. The first of the *Cæsars*, who had any thing relating to him stamped upon the Coin, was sadly put to it, when he was forced to run to the *Punick* Language for the Word *Cæsar*; which in that Tongue signified an Elephant. However, when he had once made himself Master of that lucky Discovery, he put an Elephant instead of his own Name upon the Coin. *Cicero's Cicer*, &c. shew the Humour of a People, whose fine Taste did not hinder them from relishing such things as we justly take to be Puerile.

The Reverse of this Coin has *Jupiter* sitting half naked; his Right-hand stretched out, and seems to me to hold a *Patera*; tho' *Hardouin*, whose Coin was fairer than mine, takes no Notice of it. In his Left-hand he has a *Hasta Pura*. The Inscription in mine is only, *IOVIS AXVR*, the rest of the Letters are worn away, but may be seen in *Hardouin* on *Pliny*, together with an Interpretation of *IOVIS AXVR*,
which,

which is too whimsical to be repeated, much less confuted.

The conceited Positiveness of *Hardouin's* Countryman * *Ruæus* upon *Virgil's Jupiter Anxurus*, is very remarkable ; who from this very Coin concludes, that *Jupiter Anxurus* had a Beard, and vilifies *Servius*, &c. for holding the contrary : And yet is evident that the Inscription *Jovis Axur* runs round the Figure without a Beard, *Jovis nondum barbati* ; and therefore belongs to that, and not to the Head on the other Side.

This Coin is very remarkable upon one Account ; for it will go a great way towards deciding a Dispute among the Antiquarians, *viz.* Whether there were ever struck more than one Coin with the same Die ; for I have two of the *Pansas* which agree with one another to a Tittle, and both of them with *Hardouin's Pansa* in those Parts that are fair and distinct. Indeed I could never be of the Opinion of those against whom this Argument is levelled ; for at this Rate the Charge of Coinage must have, by many Degrees, exceeded the Value of the Pieces coin'd, which would have been an Expence altogether incredible, needless and ridiculous.

				<i>gr.</i>
<i>Pansa</i> weighs in Air	-	-	-	53.000
Water	-	-	-	47.625
				<hr/>
Difference	-	-		5.375

Specific Gravity 9.860, &c.

* *Æn.* vii. 799.

The Weights of these Coins are as follow :

	gr.	sp.Gr.
<i>Jupiter</i> - - -	61.625	10.717
<i>Roma</i> - - -	52.25	10.45
<i>Roma alata</i> - -	57.875	10.0652
<i>Pansa</i> - - -	53.000	9.86
<i>Ancus</i> - - -	59.625	9.54

I perceive by this Table, that Mr. *Foubert* was wrong in saying that the best of the Consular Coins fell short of our Standard by $\frac{1}{6}$ Part, but it is true enough of the middling ones; for it will appear that Mr. *Foubert*'s Proportion will bring out the specific Gravity 10.279, which is less than the specific Gravity of *Jupiter* and *Roma*, but greater than that of any of the rest. According to Mr. *Foubert*, there are in the *Consular Denarius* 5 Parts of Silver, at 10.535 specific Gravity, and one Part of Alloy, which if it be of fine Copper, will have the specific Gravity 9.000.

Let 10.535 be multiply'd by 5, the Number }
of Parts of Silver, it gives. - - - } 52.675

To which if we add for the one Part of Copper 9.000

They will make - - - 61.675

Which being divided by 6, the whole Number of Parts, it will give 10.279, the specific Gravity, as above.

The Copper is set rather too high at 9.000, for Reasons given before; but if it were reduced to 8.000, it would give for the specific Gravity 10.1125, which still exceeds the specific Gravity of all the *Denarii* but the two first.

Upon

Upon the Review of the Whole, it may be observed,

1st. That the ancient *Consular Denarius* was about as fine as our Standard, and probably continued in that State till it was adulterated by *Livius Drusus*. This happen'd *A. U. C.* 663. Silver was first coin'd at *Rome*, *A. U. C.* 485, as we are inform'd by *Pliny*, *Edit. Hard. Fol. Tom. ii. p. 610*; so that there was a Run of good Silver 178 Years. After the Debasement by *Drusus*, the Senate seem to have restored the Money, at least to its former Purity, in which State it probably continued for some time: I say at least to its former Purity; for those of the most antient Consular Coins, which were such as had the * *Roma alata* upon them in my Collection, do not come so near our Standard as *Jupiter*, which is a *Nummus Serratus*, and was probably struck about this time; for *Marius Gratidianus* is supposed to have been the Inventor of the *Nummi Serrati*, which after the Fineness of the Coin was restored, was designed to prevent Counterfeits. The Design had its Effect for some time; but the false Coiners afterwards made a Shift to imitate them; so that they were forced to have Recourse to making Holes in them, as was practis'd in *England* in our Time. *Vide Rink, p. 65.* However, *Marius Gratidianus* grew extremely popular by his Invention, which yet did not secure him from being barbarously butcher'd by *Sylla*.

The old *Consular Denarius*, as I said before, falls something short of our Standard, but yet comes so near it, that when it is of its full Weight, 62 Grains *Troy*, it will be about 8*d.* of our Coin.

As to the *Nummi Serrati*, their Value was so well known, that even the *Germans* were not ignorant of it: *Germani pecuniam probant veterem & diu notam, Serratos, Bigatosque.*

* *Vide Rink, p. 5, 6.*

Vide *Tacit. Lips.* p. 437. Those *Nummi Serrati* were pretty common till the Time of *Augustus*; but * *Joubert* says he never saw any after that.

2 dly, My Computation has nothing to do with any of the *Denarii* but the Consular ones in perfection; for they began to degenerate, either in Weight, Fineness, or both, even before the total Ruin of the Commonwealth. Afterwards they sunk in Value from our 8 d. to 7 d. and 6 d. and I know not what.

3dly, I took notice before that *Bishop Hooper* sets the *Denarius* at 64 Grains *Troy*. I don't suppose that either he or any body else, ever saw or heard of a *Roman Denarius* of that Weight: However, as there are many Passages in ancient Authors, which imply that the *Roman Denarius* was the same with the *Attick Drachma*, which is known to be 67 Grains, I imagine the *Bishop* had a mind to trim the Matter, and make the *Denarius* 64 Grains *Troy*, instead of 62, that he might bring it nearer the *Drachma*. He might, for ought I know, have a better Reason; for if he had not, this is a very insufficient one: And when his Hand was in, he might as well have halved 5 Grains, the Difference between the *Denarius* and *Drachma*, and so have brought the *Denarius* to $64\frac{1}{2}$ Grains, instead of 64.

As an Addition to what has been said upon this Subject, I shall out of Curiosity examine what a *Denarius* of pure Silver weighing 62 Grains *Troy* would be worth in our Money; which may thus be found out.

Our Pound *Troy* of 240 Pennyweight, is coin'd into 62 Shillings, or 744 Pence. If from 240 we take 18 for the Alloy, there will remain $222 = 5328$ Grains *Troy* of pure Silver, which are contained in 744 Pence. Then as

5328

5328 : 744 : : 62 : 8.65^{d.}, which 8.65 is a small matter above 8.2^{f.}₂.

Since the specific Gravity has been so often mentioned in these Papers relating to the *Denarius*, it may be worth while to take Notice of Dr. *Barrow*'s Method of finding the Quantity of two known Metals in any Mixture without dissolving the Mass. As for Instance: The Quantity of Silver and Gold in *King Hiero*'s Crown. His Method to do this was by finding the Spaces taken up by Masses of Gold, Silver, and the Mixture of equal Weight. There is a great deal of Trouble in finding out these Spaces in the Method of * *Archimedes*, and indeed it is neither certain nor practicable in small Masses; but they are easily found out by the Knowledge of their specific Gravities.

Suppose, for instance, a Mass of Gold of the specific Gravity 20.000, an equal Mass of Silver 10.000; if these two be added together, and divided by 2, they would give the specific Gravity of the Mixture 15.000. These three equal Masses then of Gold, Mixture, and Silver, are in Weight to one another as 20.15.10. In order to find out the Spaces taken up by Masses of Gold, Mixture, and Silver of equal Weights, we must proceed by the reciprocal Proportion of their specific Gravities. The Gold was, for Instance, to an equal Mass of Silver by the Supposition as two to one; therefore the Space taken up by a Mass of Silver equal in Weight to the Gold, as 2 to 1. And the like will happen in all Cases whatever, the Proportion being observed. For the rest *vide Barrow on Archimedes*, p. 284.

I was willing, before I put an End to this long Chapter, to get a little Information of the *Roman Æs*; but not having any more antient Coin of Brass than an *Augustus*, I put that

* *Vide Vitruv. lib. ix. cap. 3.*

Observations on Dr. Arbuthnot's

to the Trial : It is of the *Æs rubrum*, or what we call Copper, and of a good Colour.

	Pw.	gr.	gr.
Its Weight in Air was	4.	18 $\frac{3}{4}$	= 114.75
Water	-	-	102.25
Difference	-	-	12.50

Specific Gravity 9.18,

which exceeds the specific Gravity of our finest coin'd Copper by 0.18 ; but if we consider the Compression made Use of in the *Roman* Coinage, which must have been far greater than in ours, this Excess of specific Gravity may be owing to that Cause, and so the finest *Æs rubrum* of the *Romans* may well enough be set at the same Standard with our own.

I afterwards tried an *Agrippa* of a worse-looking Copper, and not altogether free from Dirt and Rust. This weighed

			gr.
In Air	-	-	171.377, C°
Water	-	-	150.625
Difference	-	-	20.752

Specific Gravity 8.25 ;

which shews its Metal to be much baser than the former, and even than that of our Coin in King *Charles* the Second's Reign. Most of the Imperial Coins that I have, came nearer the Colour of *Agrippa* than *Augustus*.

I shall add two more Experiments relating to the Compression by Coinage, and the Increase of specific Gravity thereupon ensuing.

I took

I took a *S. S. Shilling* of *King George the First*, which weigh'd

In Air	-	-	-	-	gr. 91.6
Water	-	-	-	-	83.0
Difference					8.6

Its specific Gravity 10.6511.

This exceeds the specific Gravity of our Standard uncoin'd Silver, which is only 10.535; but falls short of that of *King William's Half-crown*, mention'd before, which amounts to 10.75. If there be no Mistake in *Doctor Harris's* Numbers or mine, the Half-Crown, by being letter'd upon the Edges, is more compressed and condensed in Proportion, than the Shilling.

I had some Suspicion that the Difference was, in some measure owing to the poor Relievo of *King George's* Silver Money, &c. therefore I took a Shilling of *King Charles the Second* with a bolder Relievo, and well preserved.

					pw. gr. gr.
This weigh'd in Air	-	-	-	-	3.20 = 92.000
Water	-	-	-	-	3.11 $\frac{3}{4}$ = 83.375
Difference					8.625

The specific Gravity 10.666, &c.

This exceeds the specific Gravity of the former; but does not come up to that of *King William's* Half-Crown.

CHAP. IV.

Of the ROMAN MEASURES of Capacity for Liquids.

THESE are easily had when the *Congius* is known. The *Doctor* has given us in his Book three *Congii*.

1. That of *Villalpandus* of 207.4737 solid Inches. *Vide* Arbuthnot, p. 81. How far this may be depended upon may be seen before.

2. *His own* *Congius*, which is deduced from the Pound, &c. according to his Estimate. This *Congius* gives 207.0676 solid Inches, and is what the *Doctor* makes Use of in his Tables. *Vide* Arbuthnot, p. 82. It differs from the *Congius* of *Villalpandus* by only $\overset{\text{f. In.}}{0.4061} \overset{\text{Dec.}}{}$. This *Congius* in the *Doctor's* Tables is set $\overset{\text{Pints.}}{7} \overset{\text{f. In.}}{4} \overset{\text{Dec.}}{.942}$. The Objections against his Pound hold equally against his *Congius*, for if his Pound be too large, his *Congius* must be so too.

3. The *Doctor* gives us a *Congius* deduced from the Roman Foot, which *Congius* consists of 195.3139 solid Inches, and falls short of *Villalpandus's* by 12.1598 solid Inches. *Vide* Arbuthnot, p. 81.

4. A fourth *Congius* may be had from *Pætus's* Roman Ounce of 416.610 Grains *Troy*, which will bring out the *Congius* 197.3415 solid Inches. This exceeds the third *Congius* by only 2.0276 solid Inches.

5. This is taken from *Savotus's* Roman Ounce 411.875 Grains *Troy*. This *Congius* consists of 195.0986, &c. solid Inches, and differs very little from the third, since it falls short of it by no more than 0.2153 solid Inches.

6. A sixth may be had by the Ounce of 434 Grains *Troy*, which is deduced from the *Denarius*, as I have stated it at 62 Grains *Troy*. This *Congius* is in Weight, I mean contains Water of the Weight of 52080 Grains *Troy*, which may be thus made out. A *Sextarius* contains 20 Roman Ounces of Water, and a *Congius* 6 *Sextarii*. If therefore my Ounce of 434 gr. be multiplied into 20×6 it will give 52080 Grains *Troy* for the *Congius*. These Grains being reduced into Inches, after Dr. *Arbuthnot's* Method, p. 81. will make this sixth *Congius* of 205.5789 solid Inches. He makes 760 gr. equal to 3 solid Inches. Then

Gr.	f. I.	Gr.	f. I.	Dec.
As 760	: 3	:	:	52080 : 205.5789.

Some Persons may perhaps think the *Denarius* set too high at 62 Grains *Troy*, and chuse to set it at 61. By this Estimate we should have a

7. Of 51240 Grains *Troy*, which would consist of 202.2631 solid Inches, and would differ from the *Congius* at a Medium describ'd in the next Chapter of dry Measures by no more than 0.977 Parts of a solid Inch.

The *Congii* stand thus :

	fol. In.	Dec.
<i>Villalpandus's</i> , - - - - -	207.4737	
<i>Arbuthnot's</i> , - - - - -	207.0676	
My First, - - - - -	205.5789	
My Second, - - - - -	202.2631	
<i>Pætus's</i> , - - - - -	197.3415	
<i>Arbuthnot's</i> from the <i>Roman</i> Foot, - -	195.3139	
<i>Savotus's</i> , - - - - -	195.0986	

Before we can adjust the *Congius* to the *English* Liquid Measures, we must know how many solid Inches are in our Wine Gallon, Pint, &c.

It is commonly supposed, that there are in the Wine Gallon 231 solid Inches. Upon this Supposition, which is a false one, and yet made Use of by Dr. *Arbuthnot* and others, the eighth Part of a Gallon, or Pint, will be $\frac{231}{8} = 28\frac{7}{8} = 28.875$ solid Inches. The *Congius* will be found by this Proportion:

As $28.875 : 1 : : 205.5789$ to a fourth Number, which will give the Pints, &c. in the *Congius*. This fourth Number is $7+3.4539$.

Since Dr. *Arbuthnot's* *Congius* contains $7+4.9426$, the Excess of his *Congius* above mine will be $0+1.4887$.

So much for the Estimate of the Wine Gallon made Use of by the Gaugers, and by which the Excise is paid; but they who are concern'd, know well enough that it is wrong: For by an Experiment tried before several of our most eminent Philosophers in public Posts, as *Flamsteed*, *Halley*, &c. at which Mr. *Ward* was present, the Wine Gallon amounted to no more than 224 solid Inches; at which Rate the Pint will be exactly 28 solid Inches. The Proportion will now stand thus:

As $28 : 1 : : 205.5789 : 7+9.5789$.

The Difference now between us is more considerable; for my *Congius* will exceed his by 4.6363 solid Inches.

				<i>Pt.</i>	<i>f. In.</i>	<i>Dec.</i>
My <i>Congius</i> being	-			7	+ 9.5789	
His	-	-	-	7	+ 4.9426	
				<hr/>		
Excess above his	-			0	+ 4.6363	

Pt. f. In. Dec.

The *Congius* according to my Estimate is 7 + 9.5789.

			Pt.	f. In.	Dec.
The <i>Sextarius</i> ,	or 6th Part of it,	- -	I	+ 6.2631	
The <i>Hemina</i> ,	$\frac{1}{2}$ of Sextarius,	- -	$\frac{1}{2}$	+ 3.1315	
The <i>Quartarius</i> ,	$\frac{1}{4}$ of Sextarius,	- -	$\frac{1}{4}$	+ 1.5657	
The <i>Acetabulum</i> ,	$\frac{1}{8}$ of a Sextarius,	- -	$\frac{1}{8}$	+ 0.7828	
The <i>Cyathus</i> ,	$\frac{1}{12}$ of Sextarius,	- -	$\frac{1}{12}$	+ 0.5219	
The <i>Ligula</i> ,	$\frac{1}{48}$ of Sextarius,	- -	$\frac{1}{48}$	+ 0.1304	

These being found out by dividing the *Congius*, the rest of the Measures may be found out by multiplying it.

			Gal.	Pt.	f. In.	Dec.
The <i>Urna</i> is 4 <i>Congius</i> 's,	- -	- -	3	+ 5 + 10.3156		
The <i>Amphora</i> is 8 <i>Congius</i> 's	- -	- -	7	+ 2 + 20.6312		
The <i>Culeus</i> is 20 <i>Amphora</i> 's	- -	- -	146	+ 6 + 20. 624		

			E. Gal.	Pints.	f. In.	Dec.
<i>Ligula</i> ,	- -	- -	000	$\frac{1}{48}$	00.1304	
<i>Cyathus</i> ,	- -	- -	000	$\frac{1}{12}$	00.5219	
<i>Acetabulum</i> ,	- -	- -	000	$\frac{1}{8}$	00.7828	
<i>Quartarius</i> ,	- -	- -	000	$\frac{1}{4}$	01.5657	
<i>Hemina</i> ,	- -	- -	000	$\frac{1}{2}$	03.1315	
<i>Sextarius</i> ,	- -	- -	000	I	06.2631	
<i>Congius</i> ,	- -	- -	000	7	09.5789	
<i>Urna</i> ,	- -	- -	003	5	10.3156	
<i>Amphora</i> ,	- -	- -	007	2	20.6312	
<i>Culeus</i> ,	- -	- -	146	6	20. 624	

Dr. *Arbuthnot*'s *Culeus*, in his first }
 Tables, corrected by the Pen, contains } 143 + 3 + 11.328
 and consequently falls short of mine } 3 + 3 + 9.296

In his Tables printed with his Book,	^{Gall.}	^{Pint.}	^{f. l.}	^{Dec.}
the <i>Culeus</i> is	143	+	3	+
which falls short of mine	11.095			
	3	+	3	+
	9.529			

Before I quit this Subject of the Liquid Measures, I cannot help taking Notice of a Fault in Dr. *Arbuthnot*, P. 124, in relation to the *Cyathus*.

Upon a Supposition that *Budæus*'s Emendation of a Passage in *Pliny* is right, he says, That the *Cyathus* of *Opimian* Wine came to two *Nummi*. It is strange, that he should substitute the *Cyathus* instead of the *Uncia*; for the *Uncia* alone is mentioned by *Pliny*, and there is not a Word in this Place relating to the *Cyathus*.

He could not have so far forgot himself, as not to know that the *Cyathus* and *Uncia* were two quite different Things; for the *Cyathus* was $\frac{1}{12}$ Part of the *Sextarius*; but as the *Sextarius* contain'd 20 Ounces of Water or Wine, a single Ounce was only a $\frac{1}{20}$ Part of it. Therefore the *Cyathus* was to the Ounce as 20 to 12, or exactly as 1.666, &c. to 1, and consequently the *Cyathus*, exceeded the Ounce by above one Half. This being the Case, he must certainly have substituted the *Cyathus* instead of the *Uncia*, in order to make his Computation of Interest agree with what he imagined to be *Pliny*'s. The Place in *Pliny* is certainly a very difficult one, and was *Hardouin*'s Explanation of it right, the Ounce of *Opimian* Wine was sold for 960 *Sestertii*, or 8 Pounds of our Money, according to my Value of a *Sestertius*; a Price altogether monstrous and incredible. *Vide Plin. Edit. Hard. Tom. i. p. 714.*

By *Budæus*'s Emendation of *binis* instead of *vini*, the Ounce was sold for no more than 2 *Sestertii*; a wide Difference this in their Accounts! but I think neither of them right, nor indeed capable of being reconcil'd to *Pliny*.

I shall

I shall therefore venture at another Emendation, and instead of *vini*, read *nummo*: This Emendation is not so forced as it may seem at first Sight; for I don't imagine that *nummo* was written at Length in that Place, but only its Character *N̄*. Vid. *Sertorius Ursatus*, which afterwards might easily become *NI* by the Carelessness or Ignorance of the old Librarians. *NI* not being understood by the following ones, and the Subject being *vinum*, they changed *NI* into *VINI*. If this be admitted, the Ounce of Wine was sold for a *Nummus* or *Sestertius* and all will be easy; which may thus be made out:

The *Amphora*, which contain'd 960 Ounces, was sold at first for 100 *Nummi*; at this Rate the Ounce was worth little more than 0.1 of a *Sesterce*. But a hundred and sixty Years afterwards, the Interest of a 100 *Nummi* at 6 per Cent. would amount to $160 \times 6 = 960$ *Nummi*, which being added to the principal 100, would make 1060 *Nummi* in all. If this Sum be divided by 960, the Number of Ounces in an *Amphora*, it will give 1.1 *Sestertius* for the Value of an Ounce; and as the Fraction is but a small one, and probably was neglected in Trade, an Ounce of this *Opimian* Wine was sold for a *Nummus* or *Sestertius*. Indeed *Pliny* seems to have neglected the Principal of 100 *Sestertii* in his Account, and to have regarded only the Interest 960 *Sestertii*, at which Rate the Price of an Ounce of this Wine would be precisely one *Nummus* or *Sestertius*.

I think this is rating the Price high enough; for if the *Sestertius* be set at 2*d.* which I take to be the true Value of it, the *Sextarius* which contain'd 20 Ounces, and exceeded our Pint only by a small Fraction, would have cost 3*s.* and 4*d.* of our Money; and two *Sextarii*, nearly our Quart, 6*s.* and 8*d.* This I think was a fair Price for Wine at that time of day, when Wine was so excessively cheap as
to

to be sold sometimes at 2*d.* a Gallon, or less *. *Vide* Arbuthnot, p. 125, 126.

All that Dr. *Arbuthnot* says about the *Cyathus* is foreign to the Purpose, as also what he has about the *Anatocismus*; for *Pliny* says nothing about the *Anatocismus*, and but barely mentions the *Usura modica* & civilis, which was *multiplicata semissibus*, or 6 *per Cent.*

As to the *Anatocismus*, it seems to have been reckon'd oppressive, and yet some Usurers seem not content with it, tho' they had 12 *per Cent.* besides, for their Money: *Nibil impudentius Scaptio, qui centesimis cum anatocismo contentus non esset.* *Vide Cicer. ad Attic. lib. v. Ep. 21.* Arbuthnot, p. 210.

If the former Emendation appears too harsh, I know no other Method of setting Matters right, but by supposing that if the old reading *singulas uncias VINI constituisse*, be right; *HS* has been dropp'd by the Librarians, after *vini*; but if *Budæus's* Conjecture hold good, who reads *BINIS* instead of *VINI*, the *S* in *HS* must have been dropp'd, and the Legs of the *H*, or *II*, made *binis*; or what is still more probable, out of *IIS* was made *Binis*.

Faults of this Kind are so very common in ancient Authors, that it is to be lamented that they did not write all their Sums, Dates, &c. in Words at length, instead of any numerical Characters whatever: An Error in a little Character often confounds a great Sum, and the common Writers

* What is said here is upon a Supposition that the *Romans* took Wine and Water to be of the same, or nearly the same specific Gravity. *Vide* Arbuthnot, p. 91, 92. *Lowthorp's Abridg-*

ment of the Philosophical Transactions, I. p. 610. But above all, *Fannius* in *Ward's Dissertation de Affe. Monum. Kempian.* p. 49.

seem to have been of the same Temper with our common Printers. There was so much Money to be paid for so much Work; if they could get their Money, they were not at all sollicitous whether their Work was executed well or ill.

Since I wrote what went before about the *Cyathus*, I have met with another Mistake relating to the *Cadus*, so that I am afraid the *Doctor* was not over exact in his Quotations and Translations: His Words are, *Page* 93, “ that *Julius Cæsar* at his triumphal Supper, according to *Pliny*, *lib.* 14. “ *cap.* 15. gave 100 *Cadi* of *Chios* Wine, that is, 4 Tuns, “ 25 $\frac{1}{2}$ Gallons.” I am at a Loss how to reconcile this with the Words of *Pliny*, which are these, *Cæsar Dictator triumphphi sui cænâ vini Falerni amphoras, Chii cados in convivâ distribuit.* Here is another of 100 *Cadi*, which, were we to set the *Cadus* at the highest, would have been but a Trifle at a triumphal Entertainment, especially at one of *Cæsar*’s.

The *Cadus*, according to *Hardouin*, is by some Authors set at 10 *Congii*, by others at 12. *Vide Plin. Tom. i. p. 722.* Dr. *Arbuthnot* says, *Page* 93. that the *Cadus* was the same with the *Metretes*, which by his Tables contains

Gall.	Pint.	f. In.	Dec.
-------	-------	--------	------

10 — 2 — 19.626. *Pag.* 83. He seems to make the *Cadus* the same with the *Amphora*, which he sets at

Gall.	Pint.	f. In.	Dec.
-------	-------	--------	------

7 — 1 — 10.66.

Pliny’s Meaning plainly is, that *Cæsar* gave to each Set of Company an *Amphora* of *Falernum* and a *Cadus* of *Chian* Wine. The single Sets did not consist of many Persons, but then they were vastly numerous; so that there must have been an Expence of Wine far beyond what our Author mentions. If he had reflected upon what he says, tho’ not very exactly, at *Page* 131, that *Cæsar* borrow’d of

Hirrius

Hirrius 6000 *Lampreys* for one of his triumphal Suppers, besides what he probably bought and had of his own, or from Friends, and had consider'd that there must have been other Eatables, and Wine in Proportion, he would have found that there were so many thousand Guests at one of these Entertainments, that 100 *Cadi* of *Chios* Wine would hardly have been a Taste for each.

C H A P.

CHAP. V.

Of ROMAN MEASURES of Capacity for Things dry.

THESE may be adjusted to *English* Pecks, Gallons, &c. by comparing the solid Inches in the *Modius* with those in the *English* Peck, between which there is but little Difference. The solid Inches in the *Modius* are found by those in the *Congius*; which, according to my Computation, are 205.5789. For 8 *Congii* = 1644.6312 solid Inches make an *Amphora*, which contains 3 *Modii*, consequently, if ^{f. I. Dec.} 1644.6312 be divided by 3, we shall have for the *Modius* ^{f. I. Dec.} 548.2104.

We have two different Estimates of the solid Inches and Decimals in the *English* Peck.

The first is ^{f. I. Dec.} 544.5; this is the common Reckoning. If this supposed Peck be taken from my *Modius*, it would leave a Difference of ^{f. In. Dec.} 3.7104, and consequently the *Modius* would be ^{Peck. f. I. Dec.} 1 — 3.7104.

The second Estimate of the *English* Peck, which is the true one, according to *Ward's Young Mathem. Guide*, p. 36, is ^{f. I. Dec.} 537.6. This would bring out the *Modius* that I shall stick to, ^{Peck. f. I. Dec.} 1 — 10.6104.

The *Congius* which the *Doctor* makes Use of in order to find his *Modius*, is ^{f. I. Dec.} 207.0676; which being multiplied by 8, gives the *Amphora* ^{f. I. Dec.} 1656.5408. This being divided by 3, gives the *Modius* ^{f. I. Dec.} 552.1802.

Observations on Dr. Arbuthnot's

If from this be taken the first or common *English* Peck ^{f. I. Dec.} 544.5, it will leave a Difference of ^{f. I.} 7.6802, or throwing off the two last Decimals ^{f. I.} 7.68, and consequently his *Modius* will be ^{Peck Gall. f. I.} 1 — 00 7.68, as he has rated it in his Tables.

The <i>Doctor's</i> Modius then is	-	^{Peck} 1 — 00	^{Gall.} —	^{f. In. Dec.} 7.68
Mine	- - - -	1 — 00	—	10.6104
Difference	- - - -	0 — 00	—	2.9304

which is all the Excess of mine above his.

These solid Inches are too inconsiderable to be minded in small Matters; but as they amount to ^{f. I.} 183.45th Part of my Peck, it is evident that in 183.45 *Modii*, my Measure would exceed his by about a Peck.

The *Modius*, with its Divisions, will, according to my Estimate stand thus, neglecting the Decimals of the 5th Place and beyond it:

	<i>Peck</i>	<i>Gall.</i>	<i>Pint</i>	<i>f. I. Dec.</i>
The <i>Modius</i> , - -	1	0	00	10.6104
<i>Semimodius</i> , -	0	1	00	5.3052
<i>Sextarius</i> , - -	0	0	1	0.6631
<i>Hemina</i> , - -	0	0	$\frac{1}{2}$	0.3315
<i>Acetabulum</i> , -	0	0	$\frac{1}{8}$	0.0828
<i>Cyathus</i> , - -	0	0	$\frac{1}{12}$	0.0552
<i>Ligula</i> , - - -	0	0	$\frac{1}{48}$	0.0138

It is perhaps worth observing, that if we were to compute the *Modius* between the two Extremes of *Villalpandus* and *Savotus*, we should have a new *Modius*, which would differ from

from the true *English* Peck by less than a solid Inch ; which will thus appear :

	<i>f. In.</i>	<i>Dec.</i>
The <i>Congius</i> of <i>Savotus</i> is - - -	195.	0986
Hence his <i>Amphora</i> - - -	1560.	7888
His <i>Modius</i> - - -	520.	2629
The <i>Congius</i> of <i>Villalpandus</i> is - - -	207.	4737

If these two *Congii* be added together, and divided by 2, we shall have a *Congius* between the two Extremes $\overset{\text{f. In.}}{201.} \overset{\text{Dec.}}{2861}.$

	<i>f. In.</i>	<i>Dec.</i>
Whose <i>Modius</i> found as before, will be - -	536.	7629
The <i>English</i> Peck is - - -	537.	6000
and therefore exceeds this <i>Modius</i> only - -	0.8371	

According to this Supposition, the *Roman Modius* and *English* Peck might well be reckon'd the same.

A *Congius* computed from the *Denarius* at 61 Grains *Troy*, would be $\overset{\text{f. In.}}{202.} \overset{\text{Dec.}}{2631},$ and would differ from the *Congius* at a Medium, by no more than $\overset{\text{f. In.}}{0.} \overset{\text{Dec.}}{977},$ which is less than a solid Inch.

	<i>f. In.</i>	<i>Dec.</i>
The corresponding <i>Modius</i> is - - -	539.	3682
The <i>English</i> Peck - - -	537.	6000
The Difference - - -	1.7682	

Some may possibly like these Proportions ; but I chuse rather to keep to my former ones, for Reasons given in their proper Places.


E R R A T A.

Page 3, line 10, for *Preparation* read *Proportion*. p. 12, l. 12, for *into the Decimals* read *into Decimals*. p. 14. last line, for 7 gr. $\frac{4}{5}$, or 7 gr. 74 read 7 gr. $\frac{4}{5}$, or 7 gr. 0.74. p. 15, l. 2, for 0 26 read 0 . 26. p. 17, l. 2, for *monneys* read *monnoys*. *ibid.* l. 13, for *and above* read *and is above*. p. 25, l. 7, for *yet is* read *yet it*. p. 29, l. 25, after *Gold*, add *must be to the Space taken up by the Gold*. p. 39, l. 15, for *another* read *nothing*.

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